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E60 Advanced Safety Electronics

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Model: E60

Production: Start of Production MY 2004

Advanced Safety Electronics

Objectives:

After completion of this module you will be able to:

- Identify and locate components in the ASE system
- Understand Seat Occupancy Detection (OC-3 Sensor)
- Understand diagnostic procedures of the ASE system

Advanced Safety Electronics

Advanced Safety Electronics ASE is the new passive safety system for the E60 and its variants. ASE is the successor to the Multiple Restraint Systems (MRS). The system is based on the same technology as the Intelligent Safety and Integration System (ISIS) of the E65/E66. ASE has been brought in line with the requirements specific to the E60.

Innovations of Advanced Safety Electronics

Like the E65/66, the E60 features the new byteflight fiber-optic technology. The ASE system consists of a main control unit, the Safety and Gateway Module SGM, and various satellites. Distributed with their sensors at strategic points around the vehicle, the satellites exchange information with the SGM.

The advantages of the new safety technology can be summarized as follows:

- High-speed data acquisition and transmission (10Mbit/s)
- More exact crash detection
- Networked airbag control system
- Selective triggering
- More precise control of the intelligent airbags
- Dependable triggering
- Immunity to electromagnetic interference
- Battery cable diagnosis with cutoff of the safety battery terminal when required

Advantages of the System

Multiple acceleration sensors installed at strategic points around the vehicle provide data for more exact analysis of crash situations than the MRS.

The deceleration detected by the acceleration sensors in the vehicle are all transmitted to the Safety and Gateway Module. The SGM exchanges the acceleration data with all its satellites. This provides an exact picture of the crash situation, enabling a timely and selective triggering of the actuators depending on the crash situation.

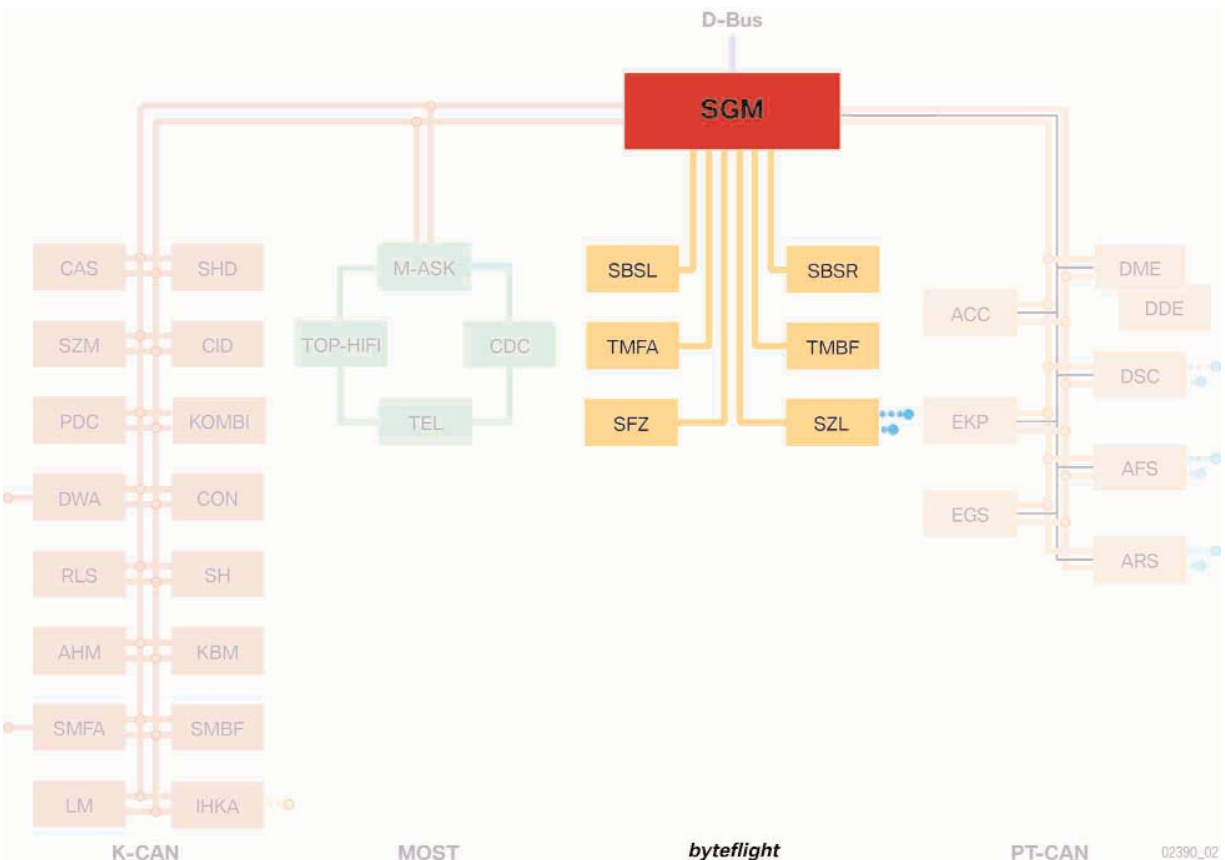
In the event of a crash, only those actuators are triggered that are necessary for optimum protection of the car's occupants. This serves to lower repair costs and reduce insurance premiums.

New Features

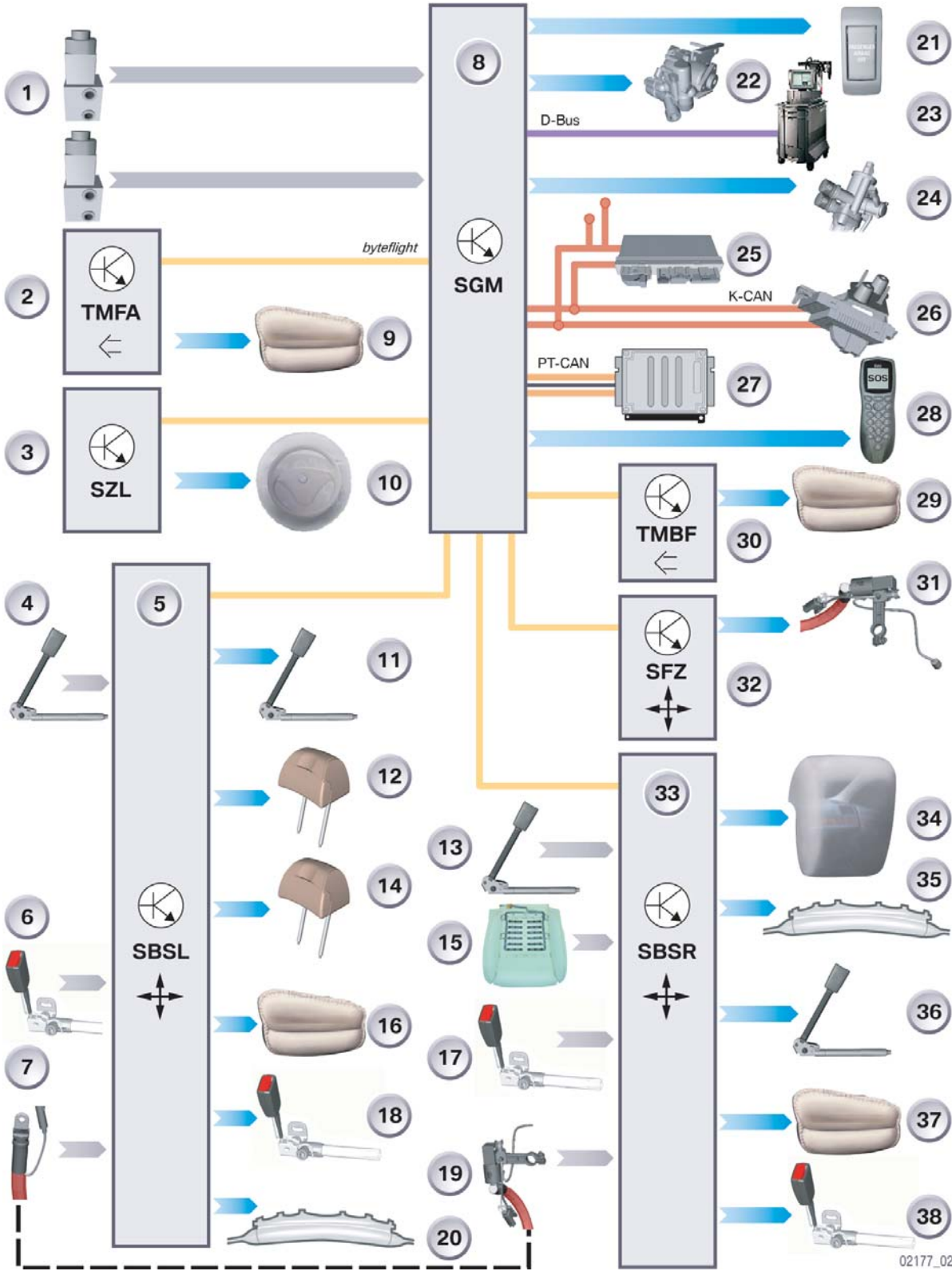
The following is a list of new features specific to the E60. Due to the different legal requirements in the USA, additional features for the passive safety system ASE were required.

The new features consist of the following:

- Up-front sensors for detecting a front-end crash and adequate provision made for occupant not wearing a seat belt when the front passenger's airbag triggers
- Passive knee protection on driver's and passenger's sides, because occupants are not required to wear seat belts by law in all 50 states
- Automatic deactivation of the airbags on the passenger side if the seat is occupied by a child restraint system holding a child up to one year old (weight dependent).
- Visual and acoustic seat-belt warning
- The cars have an emergency-call button as standard, so that occupants can call for assistance at any time in the event of a crash or a breakdown



System Overview Schematic



02177_02



Classroom Exercise - System Overview

Identify the components on the facing page and complete the chart below.

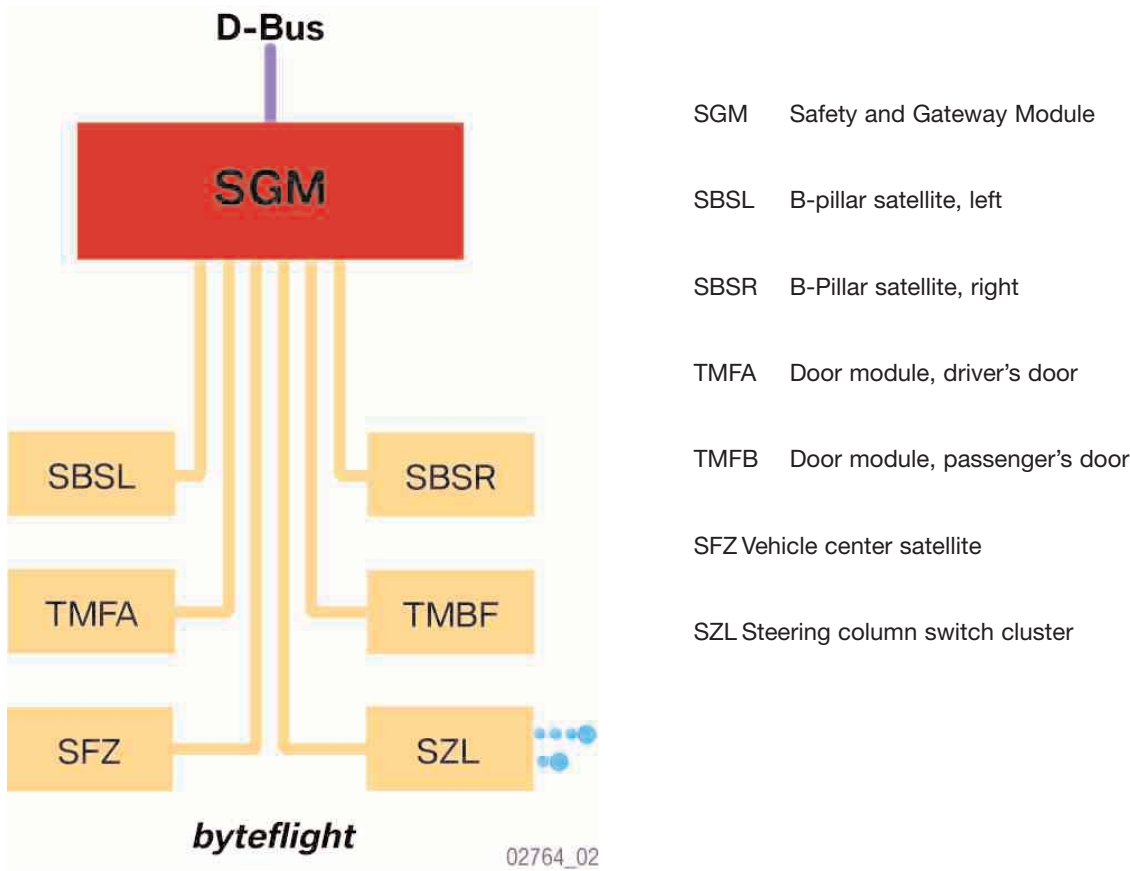
| Index | Explanation | Index | Explanation |
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System Components

byteflight

The familiar byteflight fiber optic bus that previously established a firm reputation in the E65/66 has been carried over to the E60. Extremely fast and dependable data communication is essential, given the steadily increasing numbers of sensors and actuators.

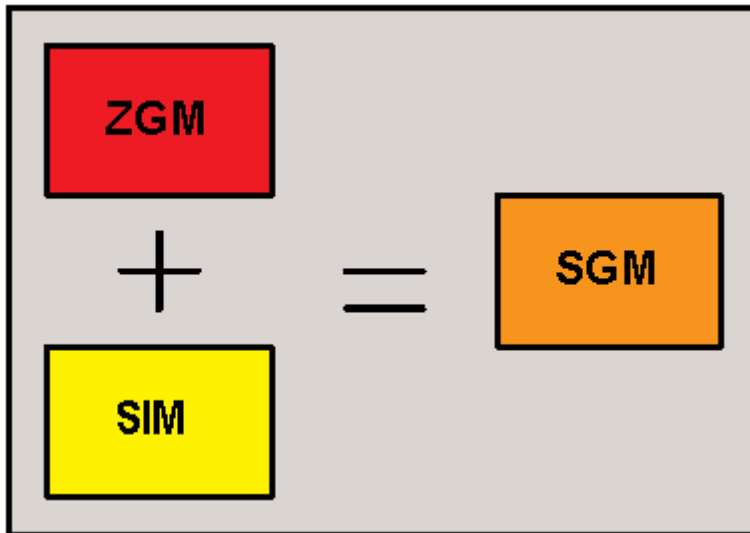
The bus system consists of the central Safety and Gateway Module SGM, and the satellites. There is a reduction in the number of satellites as compared to the E65/E66. A fiber optic star bus interconnects the satellites with the SGM. Data communication is bi-directional and very high data rates are achieved (10 Mbit/s). Each satellite has a transmitter/receiver module. The SGM has a separate transmitter/receiver module for each satellite.



Special safety protocols (telegrams) are used to provide increased system reliability and to virtually exclude the possibility of unintended triggering. In any given situation, the satellites trigger only such actuators as are necessary on receipt of a special telegram (alarm mode) from the SGM.

Safety and Gateway Module SGM

The SGM is a combination of the Safety Information Module (SIM E65) and the Central Gateway Module (ZGM E65). The SGM uses the software of the ZGM, and carries out the ZGM functions. The functions of the SIM have also been integrated and a number of new functions added.



Control units combined in the SGM

The Safety and Gateway Module is responsible for the following functions:

- Voltage supply of the satellites
- Provision of the 60 V energy reserve (SIM 400 V) in the event of failure of the power supply during an accident
- Function of the star coupler and the bus master of the byteflight
- Gateway function to the other bus systems K-CAN, PT-CAN and diagnostic bus
- The history memory has been integrated into the SGM
- Provision of the crash telegram for activating various functions in other systems (see Gateway functions)
- Drive for the Servotronic valve in the power-assisted steering
- Drive for the ECO valve of the hydraulic pump

The Safety and Gateway Module is in the module carrier behind the glove compartment and has been adapted to the ASE system.

The modules of the ZGM have been accommodated on the printed circuit board of the SIM. The ZGM has its own microprocessor and its own diagnosis address. An electrical connection takes the place of what was formerly the fiber-optic connection between ZGM and SIM. A byteflight controller is used to transmit the same telegrams as are used for communication by means of an optical link.

Note: *As far as diagnosis is concerned, note that two control units are addressed, despite the fact that they share a common housing.*

Voltage Supply

The SGM is supplied with voltage via terminal 30 and terminal 31. A voltage transformer (10.2 V) and an intelligent distributor with overcurrent protection carry voltage to the satellites. If a fault occurs, the distributor can shut off the supply to individual satellites.

Energy Reserve

At the same time the energy reserve is charged. The energy reserve consists of a storage capacitor (60 V). If the vehicle voltage drops below a defined threshold, power is tapped from the energy reserve. In this way, the entire functionality of the safety system is maintained for approximately 1 second, the time it takes to drain the energy reserve.

Note: *When carrying out work on the safety system, always bear in mind that the storage capacitors take a few seconds to discharge after the battery has been disconnected, and the safety system remains operational for this period of time.*

Star Coupler

The star coupler with the 6 transmitter/receiver modules receives its power supply (5 V) from a secondary voltage transformer. The same applies for the two microprocessors. The individual byteflights to the satellites are connected to the star coupler. The star coupler transmits a synchronization pulse every 250 microseconds. Between these synchronization pulses, the telegrams are sent from and to the satellites (bi-directional communication) on the byteflight.

The satellites accommodate acceleration sensors and pressure sensors. These are the sensors that detect a crash. The satellites send the sensor data to the star coupler. The star coupler distributes the information to all the satellites. In this way, all the satellites have the same information at their disposal.

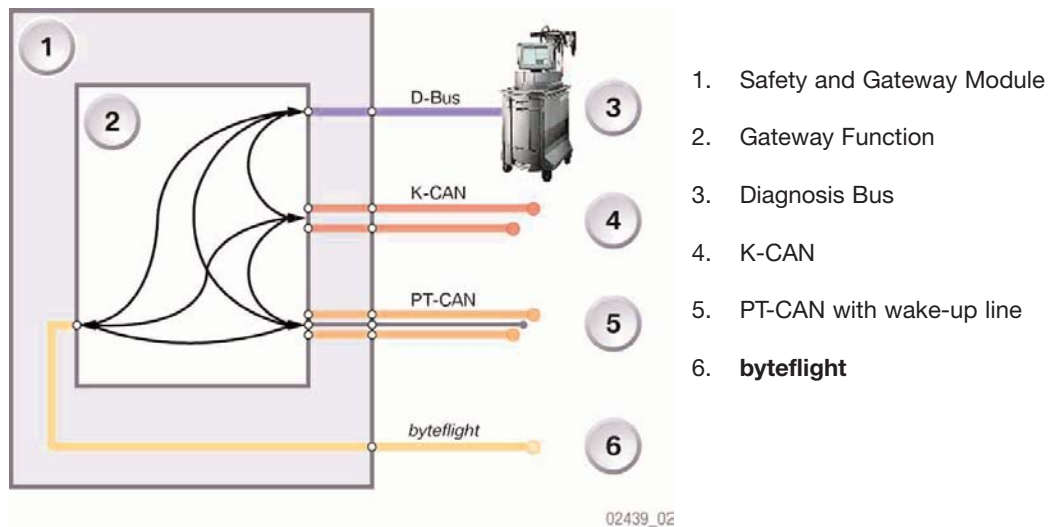
The SGM uses the information it receives to recognize a crash when it happens. The SGM compares the values with the algorithm in its processor and, if the impact is of sufficient severity, it uses the synchronization pulse to initiate the alarm mode. The alarm mode places the satellites in a triggerable state. The actuators required in any given situation are actuated, depending on the crash severity and the algorithms stored in the satellites.

Gateway

All the functions of the Central gateway Module of the E65 are integrated into the SGM. The purpose of the gateway function is to interface the various bus systems of the E60.

The bus system used in the E60 are as follows:

- Byteflight
- K-CAN
- PT-CAN
- Diagnosis bus
- MOST (by a separate gateway in the M-ASK on the K-CAN)



History Memory

A non-volatile memory is implemented in the SGM so that the following responses can be logged:

- Which bus originated the incorrect wake-up call that woke the entire system
- Which node prevented the bus system from entering sleep mode following shut down of terminal R and expiration of the run-on time (30 min).

Each entry in the history memory identifies the originator, and logs the time of day and the odometer reading. In this way, dependable diagnosis can subsequently be performed.

B-Pillar Satellite Left/Right SBSL/SBSR

The SBSL controls and monitors the following trigger circuits:

- Head airbag AITS II, left
- Active headrests left and right
- Side airbag in rear left door (optional)
- Seatbelt tensioner, left
- Seatbelt tensioner, rear left (optional)



The SBSR controls and monitors the following trigger circuits:

- Front airbag, passenger
- Head airbag (AITS II) right
- Side airbag in rear right door (optional)
- Seatbelt tensioner, right
- Seatbelt tensioner, rear right (optional)

The left/right B-pillar satellites are located low in the B pillars in the vicinity of the sill and are connected to the SGM by the bytflight.

The power supply of the satellites is also from the SGM and it is buffered by a storage capacitor. In sleep mode of the bytflight, the power supply of the satellites is deactivated by the SGM.

Each satellite has an acceleration sensor for longitudinal acceleration and one for lateral acceleration. The sensor provides a voltage as measured variable. This voltage is a measure for the positive and negative car acceleration and it is evaluated in the satellite.

The sensors continuously provide the values determined. The measured values are transferred by the bytflight to the SGM and all the satellites.

When the SGM detects a critical range, the alarm mode is set by means of the synchronization pulse.

The alarm mode places the satellites in a triggerable state. The trigger matrix stored in the satellites activates the necessary actuators depending on the crash severity.

The trigger circuits of the actuators are connected to ignition final stages in the satellites and are ignited by discharging capacitors.

The self-diagnosis of the trigger circuits during the pre-drive check and in normal operation is the same for all satellites.

Battery cable diagnosis is performed by both satellites. The connection of the monitoring line in the engine compartment is to the SBSL. The connection of the monitoring line to the battery in the luggage compartment is to the SBSR.

A precise description of the battery cable diagnosis can be found in the section on battery cable diagnosis.

| | | |
|-------------------|---------------|---|
| Operating voltage | 10.2...10.7 V | Full function |
| Operating voltage | 10.7 ... 16 V | Restricted function, diagnosis of trigger circuits not possible |
| Power intake | Typ. 90 mA | Normal operation |

Door Module, Driver's Door/Passenger Door, TMFA/TMFB

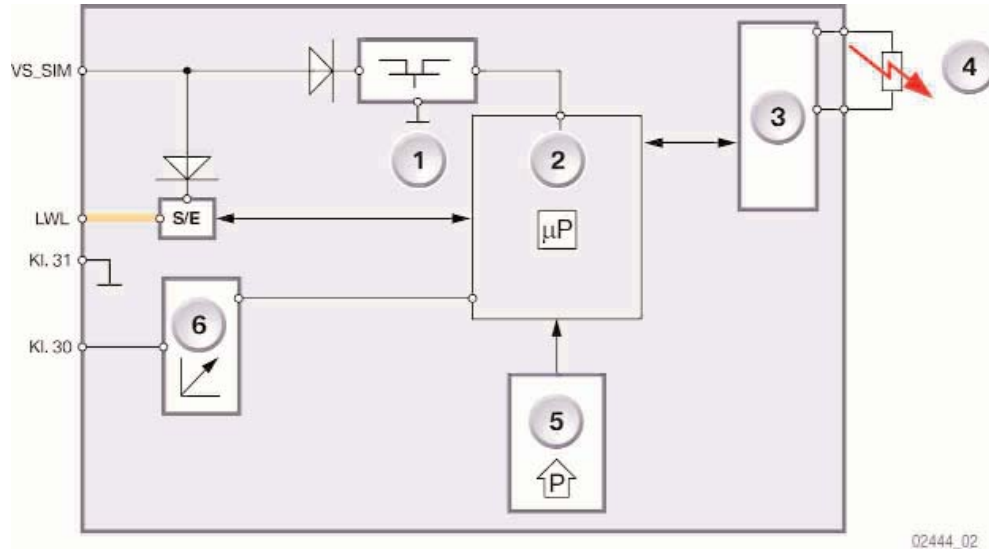
The driver's door/passenger door door module is a combination of the door module with the body electrics functions and the front-door satellite.

The driver's door/passenger door door module controls and monitors the trigger circuits for the door-mounted side airbag. The pressure sensor in the door module registers a side impact by measuring pressure increases in the door cavity.



1. Mounting screw holes
2. Inlet port to the pressure sensor
3. Connector for the switch block
4. Connector for the power supply
5. Connector for the input signals
6. Connector for the outside mirror
7. Connector for the ASE system

The description below describes only the functions that are relevant to the ASE system. The other functions are described in the section entitled General Vehicle Electrics.



- | | |
|-----------------------------------|---|
| 1. Voltage regulator | VS_SIM. Voltage supply |
| 2. Microprocessor | LWL. byteflight |
| 3. Ignition final stage | KI.30. Terminal 30 |
| 4. Igniter pellet for side airbag | KI.31. Terminal 31 ground, carried by the load connector to the door module |
| 5. Pressure sensor | S/E. Transmitter/receiver modules |

The door modules with the function of the front-door satellites are connected to the SGM by the byteflight. The power supply of the satellites is also from the SGM and it is buffered by a storage capacitor. In sleep mode of the byteflight, the power supply of the satellites is deactivated by the SGM. The door functions (FH, ASP, ZV) are sustained by means of a separate terminal 30.

A pressure sensor is integrated in the front door module. The sensor permanently measures the pressure at the door. In the event of a crash, penetration of the door outer skin reduces the volume of the door. This results in a significant pressure rise. The relative pressure change and rise in pressure evaluated over time are the most important factors for the crash evaluation.

Triggering and monitoring of the trigger circuits are similar to the criteria for the B-pillar satellites.

| | | |
|-------------------|---------------|---|
| Operating voltage | 10.2...10.7 V | Full function |
| Operating voltage | 10.7 ... 16 V | Restricted function, diagnosis of trigger circuits not possible |
| Power intake | Typ. 90 mA | Normal operation |

Vehicle Center Satellite SFZ

The vehicle center satellite controls and monitors the trigger circuit for the safety battery terminal.

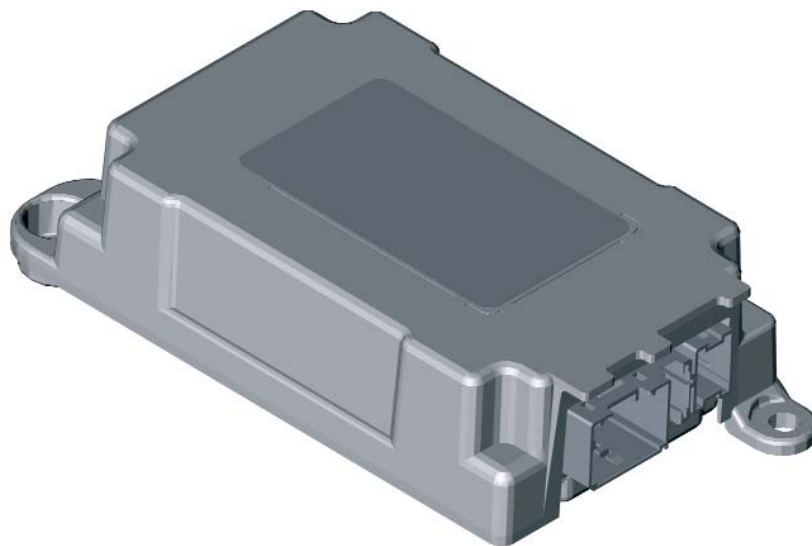
The vehicle center satellite is connected to the SGM by the bytflight. The power supply of the satellites is also from the SGM and it is buffered by a storage capacitor. In sleep mode of the bytflight, the power supply of the satellite is deactivated by the SGM.

The satellite has an acceleration sensor for longitudinal acceleration and one for lateral acceleration. The sensor provides a voltage as measured variable. This voltage is a measure for the positive and negative car acceleration and it is evaluated in the satellite.

The sensors continuously provide the values determined. The measured values are transferred by the bytflight to the SGM and all the satellites.

Triggering and monitoring of the trigger circuits are similar to the operation of the B-pillar satellites.

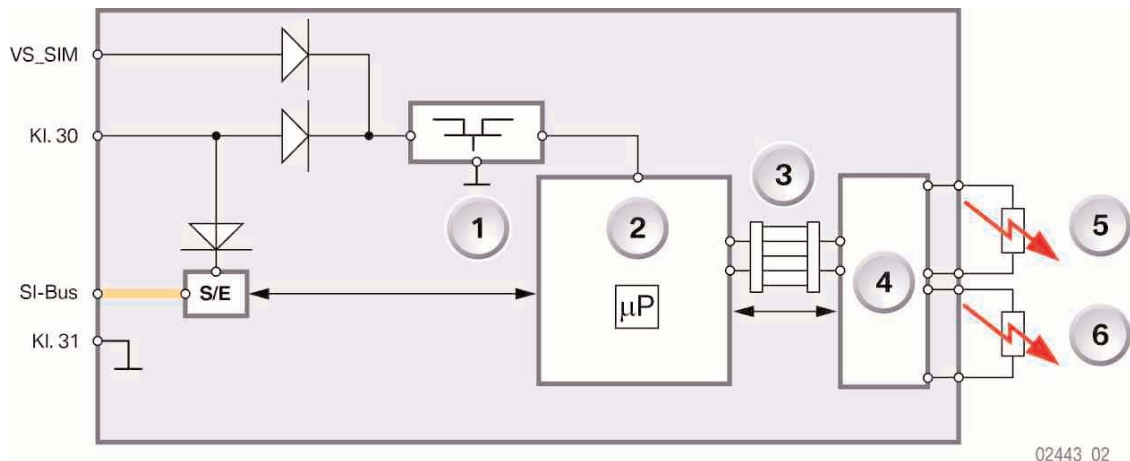
| | | |
|-------------------|---------------|---|
| Operating voltage | 10.2...10.7 V | Full function |
| Operating voltage | 10.7 ... 16 V | Restricted function, diagnosis of trigger circuits not possible |
| Power intake | Typ. 90 mA | Normal operation |



Steering Column Switch Cluster SZL

The steering column switch cluster consists of two modules, the steering column electronics (LSE) and the steering wheel electronics (LRE). The two electronic components are connected to each other by a coil spring.

The steering column switch cluster controls and monitors the two trigger circuits for the front airbag on the driver's side.



1. Voltage regulator
2. Microprocessor
3. Coil spring
4. Steering wheel electronics with trigger output stage
5. Igniter pellet for front airbag 1st stage
6. Igniter pellet for front airbag 2nd stage

| | |
|--------|------------------------------|
| VS_SIM | Voltage Supply |
| KL 30 | Terminal 30 |
| SI_Bus | bytelight |
| KL 31 | Terminal 31 |
| S/E | Transmitter/Receiver Modules |

The components connected directly to the steering column electronics are listed below:

- Connection to the **bytelight**
- The steering-angle sensor
- The direction of travel dip switch
- The wiper switch
- The switch for the cruise-control system (tempomat)

The coil spring establishes the connection to the steering wheel electronics (LRE). The coil spring carries signals and power.

The components connected directly to the steering wheel electronics are:

- The steering wheel heating with temperature sensor
- The Steptronic buttons
- The horn buttons for the fanfare horns
- The multifunction switch arrays
- The trigger output stage for the driver's side front airbag

The steering column switch cluster also features the following components:

- The switch for steering wheel heating
- The switch for steering wheel adjustment

The steering-column electronics unit (LSE) is connected to the SGM by the byteflight. Terminal 30 carries the power supply and load current.

The satellite's emergency supply is via terminal V_SIM of the SGM, with a storage capacitor as buffer. This supply is sustained even in sleep mode.

Terminal 15 is provided for the sake of redundancy. The two fanfares (horns) are powered directly by the steering wheel electronics from terminal R.

The steering column switch cluster accommodates the steering angle sensor, which sends its data by the F_CAN bus to the DSC and AFS. The data is also transmitted by the byteflight and the SGM to the PT-CAN bus. There is also a serial connection to the control unit for the Active Front Steering system.

A coil spring interconnects the steering column electronics and the steering wheel electronics. The trigger output stage and capacitor are in the steering wheel electronics. The two trigger circuits for stages 1+2 of the driver's front airbag are connected to the trigger output stage.

Triggering and monitoring of the trigger circuits are similar to the processes for the B-pillar satellites.

| | | |
|-------------------|---------------|---|
| Operating voltage | 10.2...10.7 V | Full function |
| Operating voltage | 10.7 ... 16 V | Restricted function, diagnosis of trigger circuits not possible |
| Power intake | Typ. 120 mA | Normal operation |

Belt Buckle Switch

The belt buckle switch is used to detect whether the seatbelt has been fastened or not. The detection arrives as a signal at the relevant satellites. The signal is used for evaluation for the "Seat Belt Reminder SBR" function and for selective triggering of actuators in the event of a crash.

The belt buckle switch is located in the belt tensioner of the driver's and passenger seats. If the side airbag for rear seat passengers option is installed, seat belt tensioners with belt buckle switches are installed on left and right.

The belt buckle switch is a two-wire Hall switch. The Hall switch is supplied with voltage by the satellite. The current intake of the switch is the signal for the switch position.

To reduce the general power consumption, the switch is queried in cycles. The belt buckle switch is permanently diagnosed and monitored as of terminal R.

The SBR function is an extension of the seat belt icon that remains ON for a certain period of time (6 sec) after terminal 15 ON.

If the driver pulls away without buckling the seat belt, a visual and acoustic warning is issued after the car has covered about 100 meters. The same applies for the front passenger, if the sensors indicate that the front seat is occupied, but the belt has not been buckled.

The belt reminder lights up and the acoustic warning (gong) sounds for 90 sec, unless the belt is buckled in the meantime.

The belt buckle is permanently monitored. A warning is issued if status changes while the car is on the move, in other words if the belt buckle is opened.

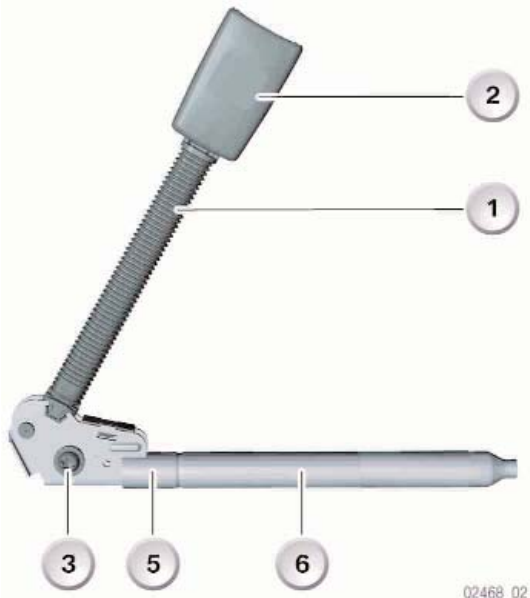
The seatbelt warning lamp is switched on as of terminal 15 On until the driver inserts the seatbelt in the seatbelt buckle.

If the seatbelt buckle is opened while the vehicle is being driven, the seatbelt warning lamp is activated again.

An acoustic warning is also issued. The acoustic signal is intermittent and is output for up to 90 seconds.

Seatbelt Tensioner

The pyrotechnic seatbelt tensioner is designed to minimize any belt slack in the pelvic and shoulder region in the event of a crash. The seatbelt tensioner is located on the driver's and/or passenger seat. In combination with the mechanical force limiter in the inertia reel, this reduces the chest load for the seat occupants.

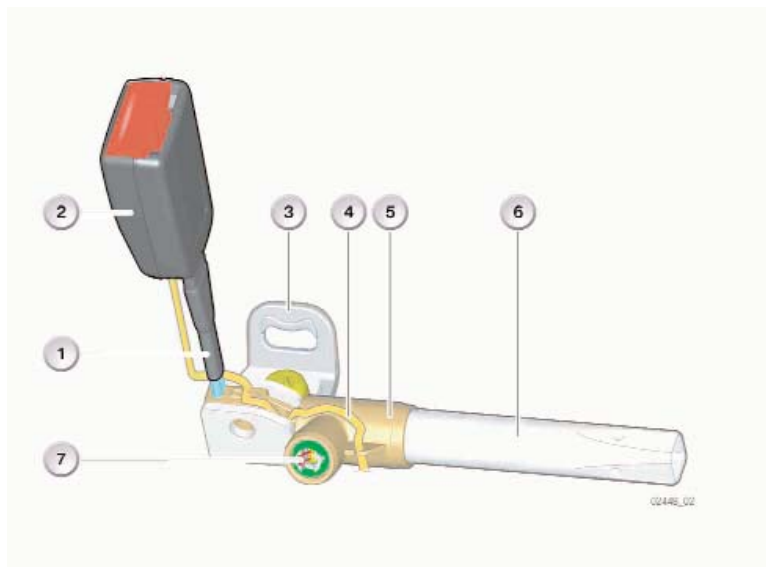


- | | |
|---------------------------------|--------------------|
| 1. Buckle strap | 4. Not Used |
| 2. Seat belt buckle with switch | 5. Gas generator |
| 3. Bracket | 6. Tensioning tube |

If the rear side airbag option is installed, seat belt tensioners are installed at the rear left and right as well. The seat belt tensioners form a unit with the seat belt buckle. In combination with the option, the inertia reels have mechanical force limiters.

Technically, the front and rear seat belt tensioners are identical. The seatbelt tensioners consist of igniter pellet, generator, plunger and operating cable.

In the event of a crash of sufficient severity, the gas generator is ignited. The gas spreads and shifts the plunger in the tensioning pipe. The cable connected to the plunger thus pulls the seatbelt buckle downwards and takes the slack from the seat belt.



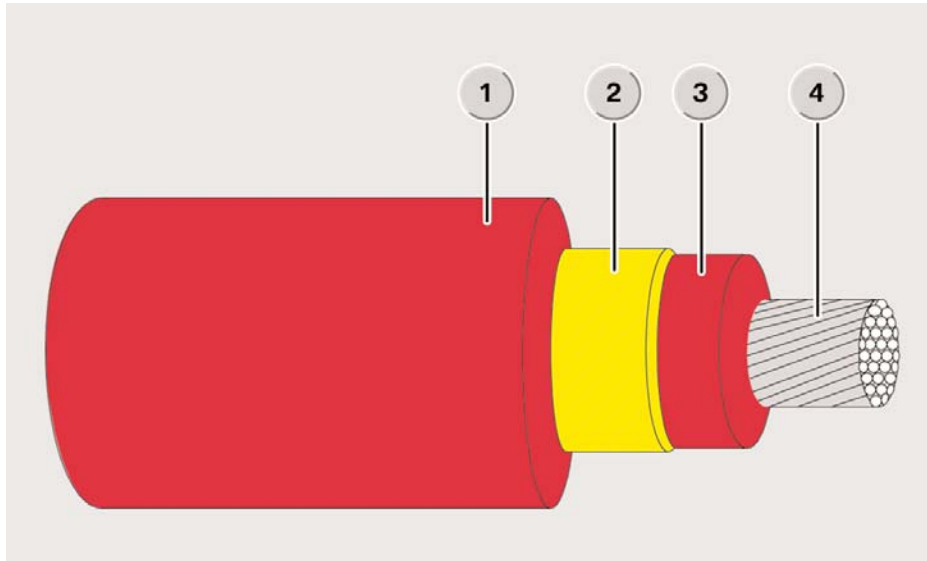
- | | |
|---------------------------------|----------------------------------|
| 1. Buckle Strap | 4. Connection for buckle switch |
| 2. Seat belt buckle with switch | 5. Gas generator |
| 3. Bracket | 6. Tensioning tube |
| | 7. Connection for igniter pellet |

The belt buckle switch is integrated in the seatbelt buckle. The rear seat-belt buckle switch is used to check whether the seat is occupied and evaluate this information.

Battery Cable Diagnosis

For the E60, the battery cable is routed from the luggage compartment outside on the underbody of the vehicle into the engine compartment.

If the cable is damaged in an accident or when driving over an obstacle (e.g. crash barrier), the battery cable is disconnected from the battery and the alternator is switched off. This prevents a short-circuit and the risk of sparks.



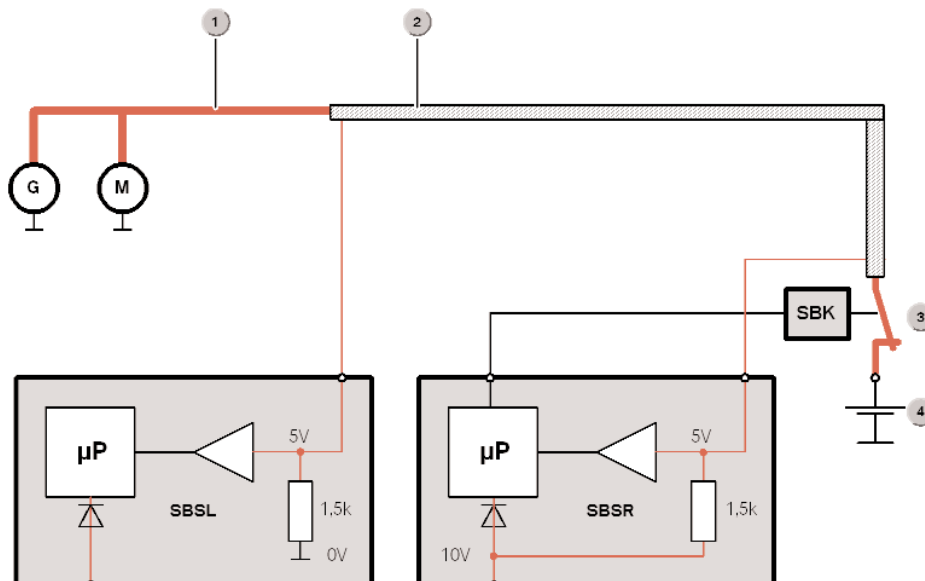
1. Outer insulation
2. Monitoring shield

3. Insulation of aluminum cable
4. Aluminum cable 120mm²

The battery cable is fitted with a low-impedance metal mesh, which is insulated against the body and against the battery cable. This metal mesh is referred to as the monitoring shield.

The battery cable is diagnosed by a special circuit between the SBSL and SBSR satellites.

The following circuit shows the functional principle of the battery cable diagnosis.



Battery cable diagnosis takes place by means of the low-impedance metal braiding of the battery cable (= monitoring shield). A connection cable exits from each end of the monitoring shield (at the safety battery terminal in the luggage compartment and at the battery earth point in the engine compartment).

The connection at the safety battery terminal in the luggage compartment is connected to the right B pillar satellite. The second connection cable in the engine compartment is connected to the left B-pillar satellite.

The satellites contain analog/digital converters that are connected to the microprocessor of the satellite. The connection cables of the battery cable diagnosis are connected to the analog/digital converters. The right B-pillar satellite contains a pull-up resistor. The left B-pillar satellite contains a pull-down resistor of the same size.

The voltage supply of the satellite (approx. 10 V) is applied at the pullup resistor. Ground is applied at the pull-down resistor. The very low-impedance cable and the resistors of the same size mean that around half the voltage (approx. 5 V) is applied at the A/D converters.

In the event of a fault, significantly different measured values result as follows:

| State | Measured value SBSL | Measured value SBSR |
|--|---------------------|---------------------|
| Battery cable OK | Approximately 5V | Approximately 5V |
| Interruption of the diagnosis connection | Approximately 0V | Approximately 10V |
| Short circuit to earth | Approximately 0V | Approximately 0V |
| Short to battery positive | Approximately 10V + | Approximately 10V + |

Every 250 microseconds, the values are measured, triggered by the synchronization pulse. If the battery cable is OK, the values are transferred every 20 ms to the SIM. If a significant deviation of the values occurs, the new values are transferred immediately.

In the following cases, the battery cable is cut off by the safety battery terminal from the battery:

- Short circuit to earth (body)
- Short circuit to battery positive

The alternator and the electric fuel pump are also de-energized at the same time.

Special Case

If the outer insulation is damaged (e.g. due to friction/scuffing), but the monitoring shield has no connection to earth, the following case could occur.

Moisture (rain) would mean that the voltage would gradually fall. A short circuit to earth would be detected, but the safety battery terminal would not be triggered.

The entry "Implausible measured value" is set in the fault code memory. This would be indicated to the driver by the airbag warning lamp.

Front Airbag, Driver

The purpose of the front airbag is to reduce the risk of the driver suffering injury in the event of a crash. The front airbag module for the driver's side is located in the impact pad of the steering wheel. The front airbag for the driver is equipped with a 2-stage gas generator.

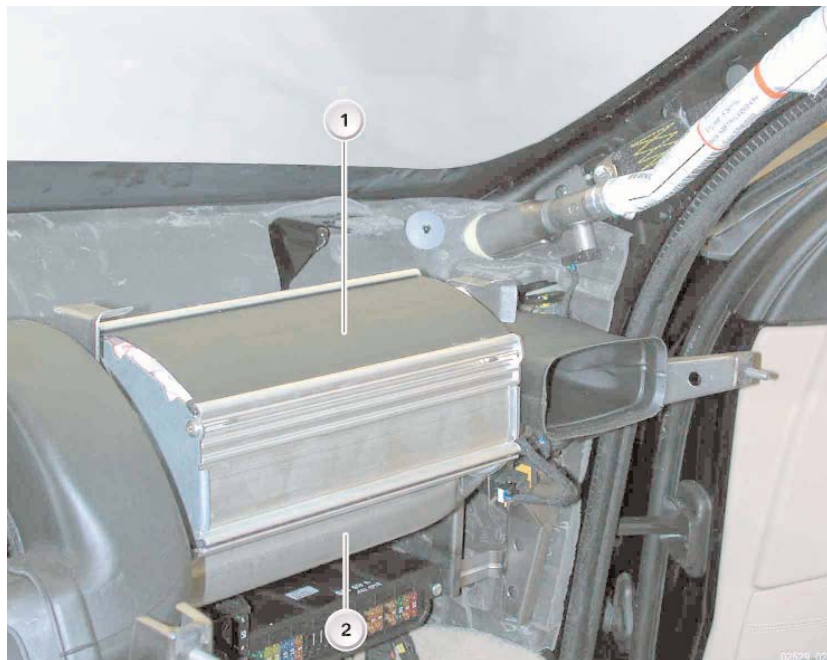


Front Airbag, Passenger

The purpose of the passenger-side front airbag is to reduce the risk of the front-seat passenger suffering injury in the event of a crash.

The front airbag is located beneath an invisible flap in the dashboard.

The airbag is a 2-stage airbag with gas generator.

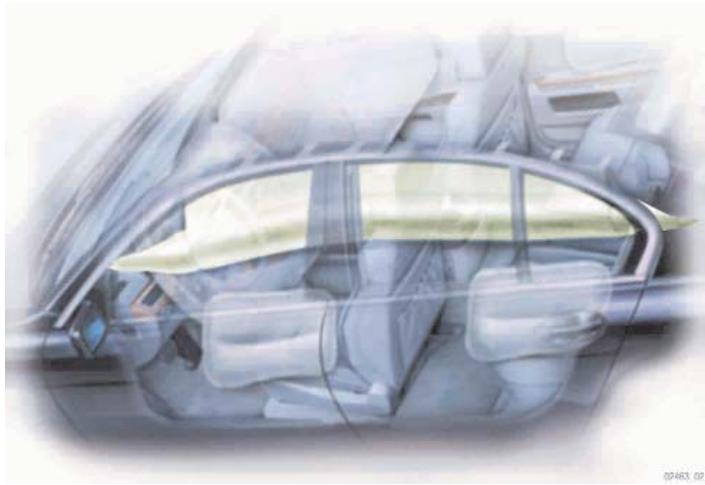


Note: If the passenger airbag module (1) is triggered, the supporting tube (2) has to be checked. During a collision with airbag deployment, the supporting tube is exposed to considerable force. Consequently, the supporting tube has to be checked and, if necessary, replaced.

Advanced ITS (Head Airbag)

Standard equipment in the E60 includes the Advanced ITS Inflatable Tubular Structure (AITS II) the advanced-design head airbag from the E65.

The differences between it and the head-protection system installed in the E39 are:



- One-part head airbag extending all the way from the A-pillar to the C-pillar
- ITS extended by a sail between ITS and roof frame

The AITS II extends all the way from the A-pillar to the C-pillar and covers the entire side zone.

In conjunction with the thorax airbags in the front and rear doors, it provides optimum side protection for all passengers.

The Advanced ITS prevents the head and other extremities of the occupants from swinging outwards. This leads to less severe neck backlash forces and less severe head injuries.

Advantages of the system:

- Extended covered area for side windows front and rear.
- Protection against glass splinters and penetrating objects.
- Optimized protection area, also for very large occupants.

Side Airbag

The side airbags in the doors reduce the risk of occupant injury in the torso region of the body in the case of a side-on crash. The side airbags are folded into an aluminum housing with a plastic cover behind the door trim. In the area of the side airbag in the door trim is a tear seam.

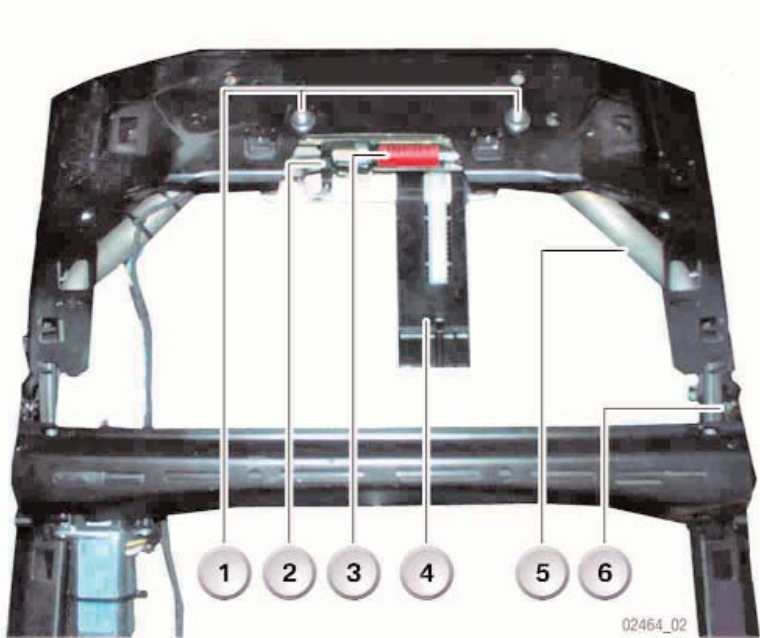
The side airbags are secured to the inner door panel with 3 screws. The plastic cover has defined breaking points.

In a side impact of sufficient severity, the side airbag is triggered. The side airbag exits through the split line and deploys between the door and the seat occupants.

Active Headrest

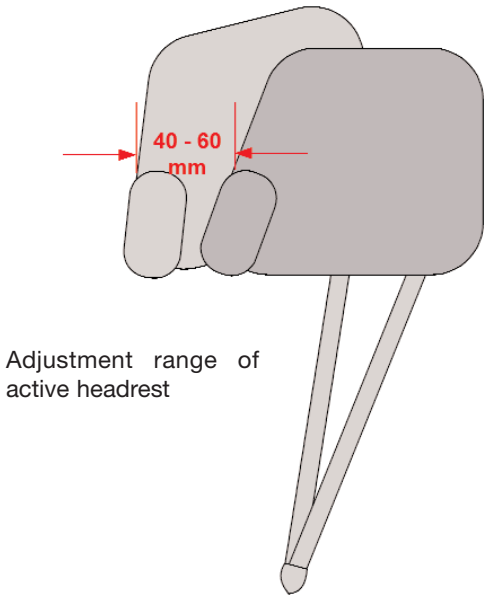
The E60 has active headrests for driver and front-seat passenger included in the multifunction seat option.

No active headrest is installed on the basic seat, as the fixed positioning of the backrest and headrest mean that the head is *always* near the headrest.



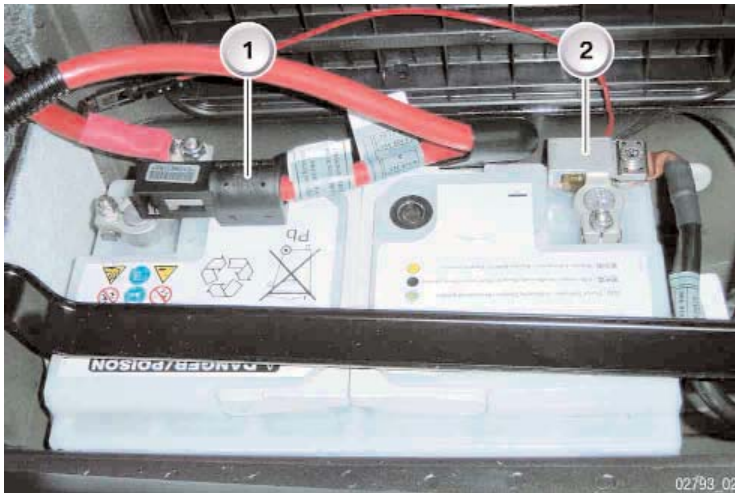
In the case of the multifunction seat, the adjustment of the headrest means that there is the possibility that the gap between the headrest and head increases. In the event of a crash, the gap would be relatively large, leading to greater strain on the cervical vertebrae. For this reason, the active headrest was developed. In the event of a crash, this reduces the gap between the headrest and head and thus the rate of cervical vertebrae injuries.

- 1. Mounting of the active headrest
- 2. Connection for igniter pellet
- 3. Gas Generator
- 4. Headrest height adjustment
- 5. Support tube
- 6. Center of rotation



Depending on the vertical adjustment of the headrest, different adjusting paths result. The adjustment of the headrest, measured on the cushion, is approx. 40 mm when the headrest is retracted. When the headrest is fully extended, the adjustment is approx. 60 mm.

Safety Battery Terminal, SBK



1. Safety battery terminal, SBK 2. Intelligent battery sensor, IBS

The safety battery terminal is located directly at the positive terminal of the battery. The structure of the safety battery terminal is technically identical to that of the MRS system.

Note: If the safety battery terminal is triggered, the battery cable has to be replaced all the way back to the main adapter point in the luggage compartment.

Up-Front Sensors

Not all federal states require car occupants to wear seat belts, so adequate provision must be made to ensure that the airbag can reliably restrain the occupant in the event of a crash.



The up-front sensors in the vicinity of the front left and right engine bearers detect deformation in the crumple zone and thus register energy absorption. The up front sensors are acceleration sensors that measure longitudinal acceleration (deceleration). The measured values are transmitted to the SGM and taken into account by the algorithm.

Note: In the event of a crash that triggers the airbags, the up-front sensors have to be replaced. The sensors might be damaged internally, even though no external damage is perceptible. Always comply with the instructions in the repair manual when replacing the up-front sensors.

Seat Occupancy Detection (OC-3 Mat)

Legislation in the USA makes it imperative for the system employed to detect occupancy of the front passenger seat to distinguish between occupancy by a small person and use of the seat to anchor a child restraint system.

A straightforward seat occupancy detector recognizes a certain weight as proof that the seat is occupied. In order to meet legislative requirements, the seat occupancy detector (SBE) was developed into an intelligent occupant classifier (Occupant Classification OC). This was achieved by means of the following measures:

- By a larger number of sensor elements
- By detection over the entire seat area
- By an intelligent electronic analyzer

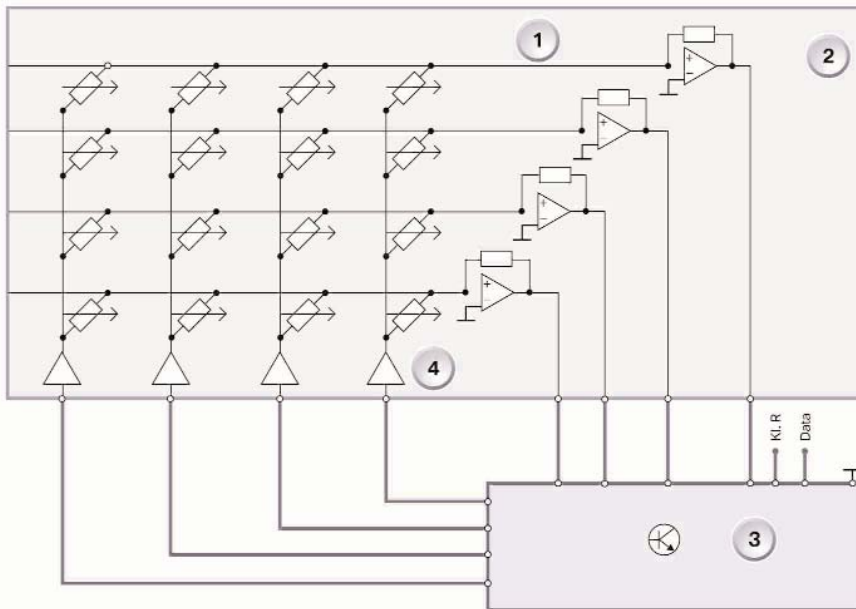


Comparison between the OC-3 sensor mat (left) and the conventional seat occupancy detection mat (right)

The OC-3 mat is capable of distinguishing between a one-year-old child in a child's seat and a light person.

The OC-3 mat is integrated into the seat area of the passenger seat. The OC-3 mat consists of conductors with pressure-dependent resistor elements (FSR, or Force Sensitive Resistance elements). The conductors are connected to the electronic analyzer.

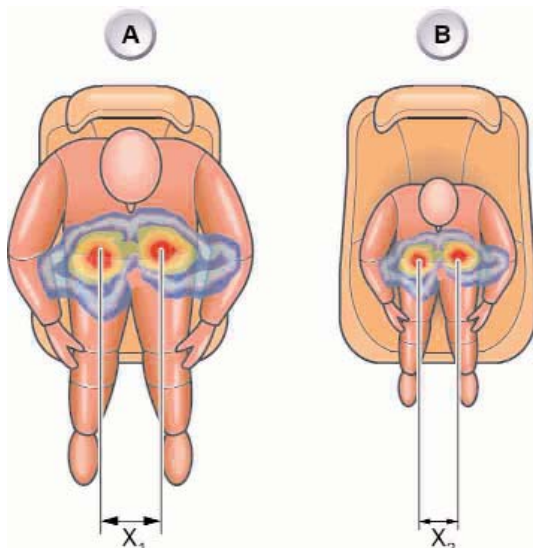
The FSR elements are wired in such a way that they can be sampled individually. When the mechanical load on a sensor element increases electrical resistance decreases and the measurement current changes accordingly.



1. FSR elements
2. Output monitoring
3. Electronic analyzer
4. Input monitoring

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By analyzing the signals from the individual sensors, the analyzer maps the occupancy of the seat surface and can identify the local concentrations of weight. The distances between the areas and the concentrations of weight indicate whether the occupant is small or large. An algorithm computes the weight class and decides whether the seat is occupied by a person or by a child's seat.



The width between the hip bones is related to the weight of the person. Consequently, the analyzer can distinguish between a light person and a heavy person.

The electronic analyzer of the OC-3 mat sends a telegram to the SBSR. If the occupant is identified as a child (based on weight) in a child's seat, the airbags on the passenger side are deactivated. The SBSR sends a telegram to the SGM, and the SGM responds by activating the airbag illuminated indicator. The airbag illuminated indicator lights up to indicate that the airbags on the passenger side have been deactivated.



Workshop Exercise

Using the DISplus/GT-1, access the control unit functions page.

Where can the status pages for the OC-3 sensor mat be found?

What module receives input "telegram" from the "electronic analyzer"?

Access the test module for the OC-3 sensor mat and list the steps below:

Locate the data line between the sensor mat and the SBSR. Interrupt the data line by grounding the signal. (to access data line, remove b-pillar trim to access SBSR or go to connector under seat from the OC-3 mat/analyzer)

What fault code is set when the data line is grounded? _____

Status of airbag deactivation indicator light _____

Perform test module for airbag deactivation indicator light. _____

What test cable is used for testing the indicator light circuit? _____

What is the voltage to the airbag indicator light (light disconnected)? _____

What module controls the airbag indicator light? _____

Why are there 2 diagnostic addresses for the SGM?

Principle of Operation

Trigger Algorithm

The Advanced Safety Electronics ASE safety system has been developed for the E60. ASE is derived from the Intelligent Safety and Integration System ISIS in the E65/66. The triggering philosophy is identical. Various degrees of crash severity and triggering thresholds are distinguished.

Crash Severity

Numerous crash and road tests under extreme conditions have been used to set the BMW triggering thresholds for all possible types of accidents. The trigger thresholds are dependent on crash severity.

Crash severity is divided into 4 groups:

- CS 0: no pyrotechnic restraint systems needed
- CS 1: light crash
- CS 2: crash of medium severity
- CS 3: severe crash

Triggering Thresholds

The triggering thresholds have been set depending on the crash severity and including other factors such as direction, overlap on collision, and depending on the evaluation as to whether the occupant was wearing a seatbelt or not.

This results in the various trigger thresholds for the activation of the various restraint systems. The various trigger thresholds means that triggering for the second stage of the front airbag can be varied, depending on the severity of the crash.

Triggering in the Event of Errors

If a fault is detected in the seatbelt buckle detection system, it is assumed that the seatbelt is not fastened. The triggering threshold is lowered. In spite of the fault recognition, an attempt is made to activate the seatbelt lock tensioner.

If a fault is detected in the seat occupation detection system, it is assumed that the seat is occupied. The restraint systems are activated.

Triggering in the Event of a Crash

The following examples illustrate the actuators that can be activated:

- Front-end crash
- Side-on collision
- Rear crash

Front-End Crash

In a front-end crash, a distinction is drawn between "light to medium severity collisions"(CS 1/CS 2) and "severe collisions" (CS 3).

Crash Severity CS1

In a crash severity CS1 collision, (light collision), the seatbelt tensioners are triggered. The driver/front passenger's airbag are not deployed if the sensors indicate that the occupants are wearing their seat belts.

Exception: If the occupants are not wearing seatbelts, the driver and passenger airbags are triggered.

Crash Severity CS2

As of crash severity CS 2, (medium-severity collision) the driver's/front passenger's airbags are deployed and the seatbelt tensioners are triggered.

The safety battery terminal is activated, the electric fuel pump is switched off, and an emergency call is placed if a correspondingly prepared telephone is present in the vehicle.

Crash Severity CS3

In a crash severity CS3 collision, (severe collision), the the driver's/front passenger's airbags are deployed and the seatbelt tensioners are triggered, but the time delay is different.

Example of Airbag Deployment

The time transient for a front-end crash is graphed here. The seat-belt buckle switch and the seat occupancy detector provide the information indicating that the passenger seat is occupied.

The collision occurs at t_0 . The mechanical lock of the seat belt prevents it unreeling. The sensors detect the deceleration forces. At t_1 the actuators are triggered by the satellites (trigger phase). The pyrotechnical actuators are triggered. The driver and passenger belt tensioners are triggered, as is the first stage of the driver's-side and passenger-side airbags.

In a crash of severity 2 or higher, the safety battery terminal is triggered at the same time, in order to prevent the battery cable from causing a short-circuit in the engine compartment.

This is followed by the deployment phase, i. e. the in flowing gas inflates the airbags. In the seat belt tensioner, the plunger is displaced by the gas in the tensioning tube. The cable connected to the plunger pulls the seatbelt buckle downward and takes up the slack in the seat belt.

At t_2 the process for the seat belt tensioners is completed and restraint by the seat belt has commenced. Gas is still inflating the two airbags.

The restraint phase starts for the driver at t_4 . Both stages of the two stage airbags can be triggered at as early a juncture as t_2 , depending on the severity of the crash. The delay between triggering of the two stages renders the airbags less likely to cause injury to the occupants.

The recoil movement of the occupants starts at time t_8 . The forward movement of the occupants ceases and they drop back into their seats.

Side-on Collision

In the event of a side-on collision, a crash severity distinction is made between light and medium-severity collisions.

If the crash severity is CS 1 (light collision) or worse, the AITS II head protection system and the side airbag on the impact side are deployed. In the event of crash severity CS 2 (medium-severity collision), the safety battery terminal is also triggered, the electric fuel pump is switched off, and an emergency call is placed if a correspondingly prepared telephone is present in the vehicle.

Rear Crash

As of crash severity CS 1, (light collision) the active headrests (if fitted) and the seatbelt tensioners are triggered. In the event of crash severity CS 2 (medium-severity collision), the safety battery terminal is also triggered, the electric fuel pump is switched off, and an emergency call is placed if a correspondingly prepared telephone is present in the vehicle.

Emergency Call, US

The E60 US offers the customer as standard a number of emergency call functions as well as a breakdown call. The emergency call functions available include the manual emergency call as well as the automatic emergency call in the event of a crash.

Even if no telephone has been ordered, every vehicle has a Telematic Control Unit TCU, a telephone aerial, a hands-free unit as well as a GPS aerial for localization.

Manual Emergency Call

The emergency call switch (4) is connected directly to the telephone. Pressing the emergency call switch sets up a voice connection with the provider "Cross Country." The voice connection is indicated by a flashing LED in the switch.

Automatic Emergency Call

In the event of a crash with corresponding crash severity, the SIM transmits a crash telegram to the TCU (via the K bus). The Global Positioning System informs the TCU of the location of the vehicle. The TCU places an emergency call, which at the same time contains the location of the vehicle.

A voice connection is set up with the provider "Cross Country" to obtain more information on the accident (severity of the accident, number of injured) so that rescue operations can be initiated.

Breakdown Call

The Breakdown call button is in the Central Information Display. Selection can be activated by means of the controller. If the breakdown call button is activated, a connection to the BMW Emergency Service of the relevant country is set up.

Airbag Indicator Lamp

The airbag illuminated indicator (3) is set in the front overhead console near the interior lights. The airbag illuminated indicator lights up if the front airbags on the passenger side have been deactivated. The emergency call switch and the two hands-free microphones are beside the airbag illuminated indicator in the overhead console.

Passive Knee Protection

The E60 US has plastic absorbers on the driver's side and passenger side. In the event of a crash, the passive knee protectors restrain the lower legs, especially if the driver or passenger are not wearing seat belts. This initiates a controlled forward shift of the upper body, which is cushioned by the relevant airbag.

Service Information

The following must be observed by Service:

- Safety and Gateway Module diagnosis
- Passenger airbag module
- Battery cable diagnosis
- Safety battery terminal
- Door module, driver's door/passenger door
- Up-front sensors

Safety and Gateway Module Diagnosis

As far as diagnosis is concerned, note that two control-unit functions (ZGM, SIM) are addressed, despite the fact that they share a common housing. Each function has its own microprocessor and its own diagnosis address.

Passenger Airbag Module

If the passenger airbag module is triggered, the supporting tube has to be checked. The forces to which it is exposed are high, and the possibility of the supporting tube deforming cannot be excluded. Consequently, the supporting tube has to be checked and, if necessary, replaced.

Battery Cable Diagnosis

If the shielding of the battery cable is damaged, the battery cable must be replaced completely. It is not permitted to repair the shielding.

Safety Battery Terminal

If the safety battery terminal is triggered, the battery cable has to be replaced all the way back to the main adapter point in the luggage compartment. Repair is not intended.

Door Module, Driver's Door/Passenger Door

When removing the door module, it is essential to ensure that the two inner screws (2) of the door module are not removed. These screws hold the housing of the door module together and ensure that the pressure sensor is sealed. If the screws are slackened there is a possibility that the pressure sensor will no longer operate correctly.

Up-Front Sensors

In the event of a crash that triggers the airbags, the up-front sensors have to be replaced. The sensors might be damaged internally, even though no external damage is perceptible. Always comply with the instructions in the repair manual when replacing the up-front sensors.

Synchronization of New Modules

When new satellite modules are fitted, these modules have no system time. Transmission of the two system time telegrams allows the module to adapt the system time. This is only possible when the stored system time in the satellite modules is smaller than the time sent.

If the system time in a module is greater than the time sent, (Ex. trying a part from another vehicle), the system time is not adopted and an entry is made into fault memory.

When the SIM or any satellite is replaced, the system time must be entered. As the system time is available in all ASE modules, it can be transferred into the new module.

This takes place via the Diagnosis Program (Service Functions). To do so, the DISplus /GT1, requests the system time from all satellites and selects the largest.

The DISplus/GT1 add an amount to this time and transmits the result into the new module as the system time. The correction amount compensates for the run time between reading from the satellites and entry into the new module.

This prevents fault messages from the satellites because the system time transferred by the new module is smaller than that stored in the satellites.